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The fuelwood consumption in a rural area of Greece

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ABSTRACT

Renewable energy sources are called to play an important role as regards the increasing energy demand worldwide. In particular, the need to address the problems created by the oil crises has distinguished the importance of renewable energy in economic development. Biomass is recognized as one of the most important renewable energy sources that can contribute decisively to the energy needs of modern society and the environment protection, in both industrialized and developing countries. A very important source of biomass is wood and especially fuelwood. In Greece, because of the economic crisis, there is an increased consumption of fuelwood, especially in rural areas.

In this paper, using a questionnaire and descriptive statistics and logistic regression analysis, we explore the determinants of fuelwood consumption in a rural area, in order to propose appropriate policies for the efficient supply of the market.

Contents

1. Introduction

The emergence and development of civilization is directly linked to increased per capita energy consumption [1,2]. It is generally assumed that energy is essential for socio-economic development and improved quality of life [1–3].

Energy (production, consumption and management of energy resources) is an essential input for all economic activity. The formulation of energy policy is therefore operating with high priority in planning economic development of countries [4–6].

The serious effects of the two oil crises in the 1970s on world economy contributed to the development of a specific policy for more rational use of energy and to the finding of new energy sources to replace oil and other fossil fuels [7].

Renewable energy sources (RES) can enhance supply diversity in energy markets, thereby, reducing dependence on oil in particular, contributes to ensuring long term sustainable energy sources, and helps reduce local and global environmental impacts and have a sustainable development. RES contribute 17% of global primary energy production, primarily from large hydroelectric facilities and from the use of traditional types of biomass and farm waste to developing countries [8].

The growing demand for energy, overall reduction of fossil fuel reserves and environmental degradation make it clear that the renewable energy sources is one of the most efficient and effective solutions to help bridge the gap between supply and demand.

Biomass is a very important source of RES with great potential especially in many developing countries where is the main energy source [9]. In rural areas of developing countries represents more than 90% of total energy [8].

The biomass production, when exercised in an appropriate and effective way, offers many economic and environmental benefits.

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However, because of the intense forests management required, we can have also negative impacts on environment and economy. In order to minimize the environmental impacts, biomass production must take place within the context of sustainable development of forests [10].

The European Union has been a leader in promoting renewable energy and particularly biomass, aiming to develop high energy efficiency, and reducing greenhouse gas emissions, by means of imposing international conventions signed to tackle climate change. The Action Plan for the biomass produced by the European Commission and applied in 2005, includes measures to increase energy production from wood, waste and agricultural crops [8,11,12]. The Action Plan includes measures to promote biomass for heating, electricity and transport, and funding research projects relating to biomass. Although there are several ongoing initiatives for energy production from biomass (bioenergy) in many countries of Europe and especially Scandinavia, the targets set have not been achieved so far.

The new directive on renewable energy (2009/28/EC) currently applied, aims to replace by 2020 20% of the total energy consumed in the EU with renewable energy sources. This percentage would be shared among EU countries, taking into account the different energy status and prospects of each country. However, it is mandatory for every country to replace 10% of transport fuel with bio-fuels [13]. Many developed countries already use a significant share of biofuels in energy supply, e.g., the Nordic countries, and other countries plan to increase their use [14].

Bioenergy is for many regions of the European Union an important factor of sustainable development, since forest plantations and agricultural energy crops are established in these areas [15,16]. A major impetus in this direction is given by the successive revisions of the Common Agricultural Policy, which include several motivations [8,17,18].

2. The use of wood and fuelwood

In Greek forest practice, the main utilization of wood after products of primary manufacture is as a source thermal energy, mainly fuelwood in round form. Products of chemical processing such as pulp and paper, products of cellulose and other chemical constituents of wood, products of pyrolysis, hydrolysis, gasification, etc. are of limited importance or non-existing [19,20].

Fuelwood is a strategic resource for future energy supply and it is commonly used locally. The traditional use of fuelwood and other forms of bioenergy have a share of 10–15% of total energy supply and are mainly used in households. The use for industrial purposes is much smaller, but remains an important resource in the effort by countries to mitigate greenhouse gas emissions [14].

Continued dependence on fossil fuels for satisfying growing energy needs can lead to environmental degradation and increases concerns about energy security. The use of forest biomass in the southern United States for bioenergy production could give new impetus to forest owners for better exploitation of their lands [21].

The wood has less impact on global warming than competing materials and is the best option for reducing greenhouse gas emissions. The wood causes fewer emissions of SO_2, generates less waste and has an advantage in terms of energy consumption [22] (Fig. 1).

The use of energy from biomass and fuelwood in particular, is still very closely tied to the quality of life in rural areas of Africa and Asia. Even in countries like South Africa, which implemented a large program of electrification, the wood remains the most common material used for cooking [23].

Moreover, wood remains the preferred energy source for most urban households in the capital of Burkina Faso. The demand for wood energy is closely linked to the household income. The utilization of fuelwood is reduced by increasing household income [24].

Fig. 1. Prefecture of Kozani.

In a region of Uganda there is almost total reliance on the use of fuelwood for home cooking and small industries. Fuelwood for domestic use is collected mainly by women and is mostly dead woods, thus its use has a low environmental impact on forest ecosystems [25].

In Tanzania the energy used by households is 80% of the total energy consumption in the country. Fuel from biomass is estimated to represent 92% of energy consumption and is often insufficient to satisfy demand. This fact has contributed significantly to environmental degradation, mainly due to deforestation [26].

In China, fuelwood and coal are major sources of energy for rural households, particularly in poor areas. In combination with population and economic growth, the increased use of firewood leads to deforestation. A survey conducted in a poor rural area of China showed that households with more educated members consume less fuelwood [27].

In Lithuania, the wood is the main energy source for the population living in suburbs, small towns and villages. Lithuanian households increased over the last decade the consumption of fuelwood five times [28].

A survey conducted in a rural area of Bangladesh showed that the number of family members, income, rate and hours of cooking affect the quantity of fuelwood used per household per year [29].

In Maputo, Mozambique, consumers are increasingly using fuelwood and make better use of different combinations of energy sources. Household consumers are generally the largest consumers of fuelwood. People who live in apartments use fuelwood less often than those living in other types of houses. Finally, there is a strong relationship between income and type of energy used. Poorer households rely more on wood for their energy needs, while households with higher incomes often make use of gas or electricity. However, this does not mean that the richest households do not use fuelwood. Rich people use fuelwood almost two days per week, so the ecological impact of this group of consumers remains significant [30].

The use of fuelwood as the primary source of energy in households causes important deforestation in various regions of the world with significant environmental and socio-economic effects [26,31–33]. Additionally, the role of women collecting fuelwood in many parts of the world is very important [25,34,35]. In northeastern India the excessive use of fuelwood as energy source has led to severe deforestation. Fuelwood is used for various activities such as cooking, heating water, house heating,

lighting, livestock, etc. Fuelwood is collected mainly by women and children [35].

Significant quantities of illegal fuelwood are collected. In many parts of the world significant amounts of fuelwood are collected illegally, other than fuelwood collected legally. In Tecpan city, Guatemala, a survey was conducted on how households are willing to pay an additional quantity to buy legitimate and not illegal fuelwood. The results confirm the importance of the economic situation of a household. The better the economic situation of the household, the higher is the willingness to pay additional money for legal fuelwood [36].

Consumers' choices play a significant role in the use of biomass for heating. A survey conducted among households in the city of Oslo that have been subsidized to buy new improved woodstoves, showed that the respondents were satisfied with the new woodstoves and considered themselves able to use and maintain the stove. They also felt that the cost of using bioenergy for heating was low. Few had problems acquiring fuelwood. Further analysis showed that the intention to continue to use the new woodstove depends on the economic benefits, performance and environmental impacts. The results show that when designing campaigns to promote the use of woodstoves and modern technology for the heating from bioenergy, issues related to the perception of users on the status of the use of bioenergy and environmental concerns should be discussed [37]. In Norway, in 2003, higher reliance on electric heating combined with the high price of electricity has led a significant number of households to consider alternative heating systems. This effort was helped by the government, which gave financial support for wood pellet heating and heat pumps. In contrast to the rapidly growing market for heat pumps, this facilitation has not contributed to the widespread adoption of wood pellet heating. The survey was conducted through questionnaires and investigated factors influencing the choice of heating system according to the perceptions of Norwegian households. The results showed that socio-demographic factors (age, income and education), communication between households, awareness of the importance of the properties—characteristics of the heating system and strategy applied, influence significantly the decision of Norwegian homeowners to select a heating system [38].

3. Renewable energy resources and fuelwood production in Greece

Greece is a country that is deficient as regards wood and wood products. More specifically, it presents a major shortage in technical (industrial) wood, with its imports accounting for over 85% of the apparent consumption. The value of wood imports is approximately 1 billion Euros, while the exports value amounts to 100 million Euros approximately [39].

Based on the above, the systematic cultivation and sustainable management of natural forests in Greece, as well as reforestation and the afforestation of agricultural land, can contribute to lowering the country's dependence on the import of wood and its products.

Greece's energy consumption passed from self-sufficiency, which existed until the late 19th century due to domestic biomass [40] to a particularly high dependence on oil, defining economic development.

Specifically, in 1973 the degree of energy dependence of the country amounted to 81.1%, in 1990 to 59.7%, and in 2003 to 66.8% [4]. The contribution of renewable energy resources to the national energy balance is 5% of overall availability of primary energy in the country and 15% of domestic production of primary energy. In 2007 the primary energy production was 1.7 Mtoe, while in early 1990 was 1.2 Mtoe. Of these, 755 ktoe were due to the use of biomass in households and 250 ktoe were due to biomass use in industry for its own purposes. Thus, the total rate of biomass reaches 57.6% [41].

Hence, search and development for new domestic energy sources is necessary. The main form of biomass energy is fuelwood, converted into charcoal. Agricultural crop residues such as straw and sunflower stalks, corn and cotton, are dominate [4]. The biomass (agricultural and forestry) as one of the renewable energy resources, is likely to contribute to some extent to reduce energy dependence Greece, through appropriate policies.

Greece is a mainly mountainous country and two thirds of its area is mountainous and hilly area. Forests and other tree land cover of 6513,068 Ha, 49.3% of the total area of the country [42].

The Greek forestry is closely linked to the economy of the mountainous areas of the country and contributes to increase the income of mountainous people (wood production other forest products). It also contributes to improve the quality of life in general, offering a number of benefits (climatic, protective, aesthetic) [18].

The basic objective of the Greek forest policy is the use of forests in order to deliver the maximum possible production, based on climate–soil conditions and in order to cover insufficiency in wood and wood products as more as possible [1].

Fuelwood is one of the main products of Greek forests [43,44] and represents over 65% of total timber production [45,46]. The total wood production in recent decades has diminished considerably. The reduction, however, is greater in the fuelwood than in the industrial wood. In 1922 the production of fuelwood was 5.0 Mm^3, in 1990 1.7 Mm^3, and in 2007 to 1.2 Mm^3 [46].

In the past, there was a very high consumption of fuelwood, especially in the rural areas of the country. Gradually, however, demand dropped significantly due to urbanization and wood has been replaced by solid and liquid fuels. The successive oil crises and the use of fireplaces in houses both in rural and urban areas have contributed to some level to improve the demand for fuelwood [45,47,48].

The harvesting of large quantities of fuelwood from the Greek forests for many years without any measures, in an irrational way, and only in accordance to the desires of the people, especially in mountainous areas even nowadays, contributed and still contributes to the degradation of forests with significant social, environmental and economic impacts [49].

4. Study area and research methodology

The survey was conducted in the prefecture of Kozani, and particularly in districts that had a population of less than 10,000 residents according to 2001 census. The study area is located in northern Greece and is characterized by high levels of industrialization, because there are power plants that produce electricity with the use of lignite (Map 1). This fact contributed significantly to the development of the area as the main occupation of the residents before the establishment of industries was agriculture. The area produces 1.3% of GDP of Greece – this percentage is almost stable for the last years – and 15% of the total energy production of Greece [50].

The area's forests are dominated by oak, beech, black pine and broad-leaved evergreen shrubs [51]. In the agricultural land that was afforested within the framework of European regulations, black locust is predominant.

Forest management in the area is carried out according to management plans which study the prevalent natural, economic and social conditions. The objectives of forestry are determined and forest management is organized on a space and time basis, in

order to achieve its aims. Furthermore, all required investments for the construction of forest improvement projects are addressed, and the relations between the forest and the mountainous population regulated.

The survey was conducted in 2010.

The aim of this study is to investigate the views of rural households in the prefecture of Kozani, as regards the use of fuelwood, in order to point out the potential of this fuel in their current and future energy needs.

The data collection was carried out by interviewing personally the residents and by distributing questionnaires, which had closed-type questions mostly.

In structuring the questionnaire we took into account the relevant literature on the use of fuelwood and the role of forests in the increase of wood production [18,52–55].

The primary data collected and presented in this research are related to the socio-demographic characteristics of the respondents' views and attitudes, as consumers, about the role of fuelwood in their energy needs, future prospects and the role of forests and other lands in wood production.

The sampling method chosen for the collection of the questionnaires was Simple Random Sampling, because of its advantages [56–58]. The population under study consists of the households in the rural areas of the prefecture of Kozani, as they were recorded in the electricity lists.

Sample size is estimated based on simple random sampling methodology [56,57]. Before calculating the size of the sample we pre-sampling (sample 50 persons).

In order to determine the overall sample size we applied the formula

$$n=\frac{t^2\hat{p}(1-\hat{p})}{e^2} \tag{1}$$

This methodology has been used in similar surveys [54,55,59]. For $p=0.5$, $t^2=1.96$ and $e=0.05$ the sample size is 384.16 households/individuals. From each household we selected one person.

Finally, in our survey, the sample is 690 households/individuals from which 440 are fuelwood consumers.

Statistical and econometric analyses were carried out with the help of the statistical package SPSS 15.0. Descriptive statistics and logistic regression methodology were applied. Logistic Regression is useful for situations in which we want to be able to classify subjects based on values of a set of predictor variables. In our study, we conducted a survey in which participants who use fuelwood as energy source, are asked if they believe that fuelwood demand in the near future will increase, decrease or stay the same as nowadays. Using logistic regression, we can explore the trend of fuelwood use, and plan our strategy policy accordingly.

For a dependent variable with k categories, consider the existence of k unobserved continuous variables, $Z_1, \ldots, Z_k$, each of which can be thought of as the propensity toward a category. In the case of a survey concerning fuelwood consumers' belief, Z_k represents a consumer's propensity toward selecting the k-th option (future fuelwood use in our study), with larger values of Z_k corresponding to greater probabilities of choosing that option (assuming all other Z's remain the same).

Mathematically, the relationship between the Z's and the probability of a particular outcome is described in this formula.

$$\pi_{ik}=\frac{e^{z_{ik}}}{e^{z_{i1}}+e^{z_{i2}}+\cdots+e^{z_{ik}}} \tag{2}$$

where, π_{ik} is the probability the i-th case falls in category k, z_{ik} is the value of the k-th unobserved continuous variable for the i-th case, Z_k is also assumed to be linearly related to the predictors.

$$z_{ik}=b_{k0}+b_{k1}x_{i1}+b_{k2}x_{i2}+\cdots+b_{kj}x_{ij}$$

where, x_{ij} is the j-th predictor for the i-th case, b_{kj} is the j-th coefficient for the k-th unobserved variable, j is the number of predictors.

If Z_k were observable, we would simply fit a linear regression to each Z_k and be done. However, since Z_k is unobserved, we must relate the predictors to the probability of interest by substituting for Z_k.

$$\pi_i=\frac{e^{b_{k0}+b_{k1}x_{i1}+\cdots+b_{kj}x_{ij}}}{e^{b_{10}+b_{11}x_{i1}+\cdots+b_{kj}x_{ij}}} \tag{3}$$

As it stands, if we add a constant to each Z, then the outcome probability is unchanged. This is the problem of non-identifiability. To solve this problem, Z_k is (arbitrarily) set to 0. The k-th category is called the reference category, because all parameters in the model are interpreted in reference to it. It is a good idea (for convenience sake) to choose the reference category so that it is the standard category to which others would naturally be compared. In our study, that is the belief that fuelwood demand in the near future will stay the same as nowadays.

$$\begin{aligned}\pi_{ik}(\text{with constants added to } Z\text{'s}) &= \frac{e^{Z_{ik}+c}}{e^{Z_{i1}+c}+e^{Z_{i2}+c}+\cdots+e^{Z_{iK}+c}}\\ &= \frac{e^{Z_{ik}}e^{c}}{e^{Z_{i1}}e^{c}+e^{Z_{i2}}e^{c}+\cdots+e^{Z_{iK}}e^{c}}\\ &= \frac{e^{Z_{ik}}}{e^{Z_{i1}}+e^{Z_{i2}}+\cdots+e^{Z_{iK}}}\\ &= \pi_{ik}\end{aligned} \tag{4}$$

The coefficients are estimated through an iterative maximum likelihood method.

As part of an effort to estimate the trend of fuelwood use, we sampled 440 respondents, noting 15 variables (12 factors and 3 covariates).

The 12 factors were:

Q_8: What is the main problem facing the use of fuelwood?
Q_{11}: Do you find easily the desired quantity of fuelwood in the market?
Q_{16}: In what type of residence do you live?
Q_{18}: The state helps to promote the use of fuelwood?
Q_{19}: The state contributes to the promotion of renewable energy?
Q_{23i}: Do you agree to provide subsidies for forestry activities?
Q23ii: Do you think that fertile and productive agricultural land could be planted with forest trees?
Q_{23iii}: Do you think that if there were not any subsidies, owners of agricultural lands would not plant forest trees in their properties?
Q_{23iv}: Do you think that infertile agricultural lands could be planted with forest trees?
Q_{23v}: Do you think that the procedures for approval of subsidies for forestry activities are complex and take a long time?
Q_{23vi}: Do you think that the regulations governing the planting of land with forest trees and forest management are many?
Q_{23vii}: Do you think that bare mountainous forest lands could be afforested?

The 3 covariates were:

Q_{10}: At what price did you bought your fuelwood (year 2010) EUR/ton?
Q_{14}: What is the year of construction of your house?
Q_{15}: How many square meters is the area of your house?

Also, in this survey we used Logistic Regression to determine profiles for each option (belief that fuelwood demand in the near

future will increase, decrease or stay the same as nowadays; this was the question Q_9, which was used as the dependent variable).

5. Results–discussion

Most of the fuelwood consumers in this study said that the main problem in the use of fuelwood is that it requires additional work (transport, storage etc.). The majority of respondents (95.5%) find easily the amount of fuelwood that they need in the markets, which indicates the adequacy of this product. The 84.5% of respondents live in detached houses, not apartments (which is usual in rural areas).

Very few respondents (10%) believe that the state contributes in promoting the use of fuelwood. A 10% of the respondents also said that the state contributes to the promotion of renewable energy in general. However, the majority (68.2%) said that they are not familiar with the role of the state as regards the promotion of fuelwood and renewable energy sources (75.5%).

Respondents also pointed out a number of issues about the role of subsidies in fuelwood production. Specifically, the majority (76.4%) believe that subsidies play an important role in afforestation of agricultural lands. More than half (64.5%) consider that the procedures for the approval of subsidies for forestry activities is quite complex and time consuming, like the overall operation of the Greek public administration.

The majority (89%) believe that the infertile agricultural lands could be planted with forest trees. Planting these areas with forest trees will contribute to the increase of fuelwood production and the efficient supply of the market.

Just over half of the respondents (57.3%) know that there are no regulations regarding the planting of forest trees on agricultural lands. The majority (95.5%) agree that the bare mountainous forest lands could be afforested, in order to increase the supply of fuelwood in the market.

As regards the future demand for fuelwood, respondents are confused. Almost half (48.2%) believe that future demand will increase, 49% believe that will be the same as today and only 2.7% believe it will decrease.

The majority (85%) of those who believe that the future demand for fuelwood will increase, they agree to the afforestation of mainly infertile agricultural lands. The majority (94.4%) of those who believe that the future demand for fuelwood will remain the same, they also agree to the afforestation of mainly infertile agricultural lands.

The majority (90.6%) of those who believe that the future demand for fuelwood will increase, they think that bare mountainous forest lands could be afforested. All those who believe that the future demand for fuelwood will remain consistent (100%), they think that bare mountainous forest lands could be afforested.

All the above statements show the important role of both agricultural land and bare mountain forests in increasing the

Table 1
Views of individuals for fuelwood use and the forestry.

		N	Marginal Percentage
Q9: What do you think is the prospect of demand for fuelwood in the near future?	Greater than nowadays	212	48.2%
	Same as nowadays	216	49.1%
	Smaller than nowadays	12	2.7%
Q8: What is the main problem facing the use of fuelwood?	They occupy a large volume	68	15.5%
	Additional work is required (transportation, storage etc.)	252	57.3%
	Maintenance of stoves and fireplaces (smudging, various impurities etc.)	120	27.3%
Q11: Do you find easily the desired quantity of fuelwood in the market?	Yes	420	95.5%
	No	20	4.5%
Q16: In what type of residence do you live?	Detached house	372	84.5%
	Apartment	68	15.5%
Q18: The state helps to promote the use of fuelwood?	Yes	44	10.0%
	No	96	21.8%
	I do not know	300	68.2%
Q19: The state contributes to the promotion of Renewable Energy?	Yes	44	10.0%
	No	64	14.5%
	I do not know	332	75.5%
Q23i: Do you agree to provide subsidies for forestry activities?	Yes	416	94.5%
	I do not know/answer	24	5.5%
Q23ii: Do you think that fertile and productive agricultural lands could be planted with forest trees?	No	220	50.0%
	Yes	120	27.3%
	I do not know/answer	100	22.7%
Q23iii: Do you think that if there weren't any subsidies, owners of agricultural lands wouldn't plant forest trees in their properties?	No	16	3.6%
	Yes	336	76.4%
	I do not know/answer	88	20.0%
Q23iv: Do you think that bare agricultural lands could be planted with forest trees?	Yes	392	89.1%
	I do not know/answer	48	10.9%
Q23v: Do you think that the procedures for approval of subsidies for forestry activities are complex and take a long time?	No	8	1.8%
	Yes	284	64.5%
	I do not know/answer	148	33.6%
Q23vi: Do you think that the regulations governing the planting of land with forest trees and forest management are many?	No	8	1.8%
	Yes	252	57.3%
	I do not know/answer	180	40.9%
Q23vii: Do you think that bare mountainous forest lands could be afforested?	No	4	0.9%
	Yes	420	95.5%
	I do not know/answer	16	3.6%
Valid		440	100%
Missing		0	
Total		440	

production of fuelwood and in supplying efficiently the market Table 1.

Table 2 presents two tests of the null hypothesis that the model adequately fits the data. If the null is true, the Pearson and deviance statistics have chi-square distributions with the displayed degrees of freedom. If the significance value is small (less than 0.05), then the model does not adequately fit the data. In this case, its value is greater than 0.10, so the data are consistent with the model assumptions.

Table 3 is a likelihood ratio test of our model (Final) against one in which all the parameter coefficients are 0 (Null). The chi-square statistic is the difference between the −2log-likelihoods of the Null and Final models. Since the significance level of the test is less than 0.05, we can conclude the Final model is outperforming the Null.

When constructing a model, we generally want to only include predictors that contribute significantly to the model. Table 4 tests each variable's contribution to the model. For each effect, the −2log-likelihood is computed for the reduced model; that is, a model without the effect. The chi-square statistic is the difference between the −2log-likelihoods of the reduced model from this table and the Final model reported in the model fitting information table. If the significance of the test is small (less than 0.05) then the effect contributes to the model. As seen in likelihood ratio tests table, only Q_{23ii} variable is significant. We should also note that the intercept cannot be tested in this model because removing the intercept simply causes one of the previously redundant factor levels to become non-redundant.

In the linear regression model, the coefficient of determination, R^2, summarizes the proportion of variance in the dependent variable associated with the predictor (independent) variables, with larger R^2 values indicating that more of the variation is explained by the model, to a maximum of 1. The following methods are used to estimate the coefficient of determination, when the dependent variable is categorical: Cox and Snell's R^2 [60], Nagelkerke's R^2 [61] and McFadden's R^2 [62]. In our study, R^2 statistics are considered adequate (Table 5).

What constitutes a good R^2 value varies between different areas of application. While these statistics can be suggestive on their own, they are most useful when comparing competing models for the same data. The model with the largest R^2 statistic is best according to this measure. In our study, R^2 statistics are considered adequate (Table 5).

Table 2
Goodness-of-fit.

	Chi-Square	df	Sig.
Pearson	108.478	96	0.181
Deviance	78.441	96	0.904

Table3
Model fitting information.

Model	Model fitting criteria	Likelihoodratio tests		
	−2 Log Likelihood	Chi-square	df	Sig.
Intercept only	175.853			
Final	78.441	97.412	46	0.000

Table 5
Pseudo *R*-Square.

Cox and snell	0.588
Nagelkerke	0.736
McFadden	0.554

Table 6
Classification.

Observed	Predicted			
	Greater than nowadays	Same as nowadays	Smaller than nowadays	Percent correct (%)
Greater than nowadays	45	8	0	84.9
Same as nowadays	9	45	0	83.3
Smaller than nowadays	0	0	3	100.0
Overall percentage (%)	49.1	48.2	2.7	84.5

Table 4
Likelihood ratio tests.

Effect	Model fitting criteria	Likelihood ratio tests		
	−2Log likelihood of reduced model	Chi-square	df	Sig.
Intercept	78.441[a]	0.000	0	–
Q10: At what price did you bought your fuelwood (year 2010) EUR/ton?	80.213[b]	1.772	2	0.412
Q14: What is the year of construction of your house?	78.650[b]	0.209	2	0.901
Q15: How many square meters is the area of your house?	82.986[b]	4.545	2	0.103
Q8: What is the main problem facing the use of fuelwood?	87.246[b]	8.805	4	0.066
Q11: Do you find easily the desired quantity of fuelwood in the market?	82.755[b]	4.314	2	0.116
Q16: In what type of residence do you live?	78.869[b]	0.428	2	0.807
Q18: The state helps to promote the use of fuelwood?	81.089[b]	2.648	4	0.618
Q19: The state contributes to the promotion of Renewable Energy?	78.475[b]	0.034	4	1.000
Q23i: Do you agree to provide subsidies for forestry activities?	79.790[b]	1.349	2	0.509
Q23ii: Do you think that fertile and productive agricultural lands could be planted with forest trees?	103.805[b]	25.364	4	0.000
Q23iii: Do you think that if there were not any subsidies, owners of agricultural lands would not plant forest trees in their properties?	82.664[b]	4.224	4	0.377
Q23iv: Do you think that infertile agricultural lands could be planted with forest trees?	79.464[b]	1.023	2	0.600
Q23v: Do you think that the procedures for approval of subsidies for forestry activities are complex and take a long time?	79.919[b]	1.478	4	0.831
Q23vi: Do you think that the regulations governing the planting of land with forest trees and forest management are many?	80.383[b]	1.942	4	0.746
Q23vii: Do you think that bare mountainous forest lands could be afforested?	79.295[b]	0.854	4	0.931

Table 7
Parameter estimates.

What do you think is the prospect of demand for fuelwood in the near future?[a]		B	Std. error	Wald	df	Sig.	Exp(B)	95% Confidence interval for Exp(B)	
								Lower bound	Upper bound
Greater than nowadays	Intercept	50.682	2102.725	0.001	1	0.981			
	Q15	−0.023	0.012	3.862	1	0.049	0.977	0.954	1.000
	[Q23ii=1]	5.146	1.354	14.445	1	0.000	171.755	12.089	2440.140

Table 6 shows the practical results of using the multinomial logistic regression model. For each case, the predicted response category is chosen by selecting the category with the highest model-predicted probability. Cells on the diagonal are correct predictions, while cells off the diagonal are incorrect predictions. Of the cases used to create the model, 45 of the 53 respondents who believe that fuelwood demand will increase are classified correctly, 45 of the 54 respondents who believe that fuelwood demand will stay the same are classified correctly, and all 3 respondents who believe that fuelwood demand will decrease are classified correctly. Overall, 84.5% of the cases are classified correctly. This compares favorably to the "null", or intercept-only model, which classifies all cases as the modal category. It is clear that the trend of fuelwood use is stable to increasing, and certainly not decreasing, so it's worth apply and support policies and strategies that enhance fuelwood production.

Also, according to Table 1, the modal category is that the fuelwood demand will stay the same as nowadays, with 49.1% of the cases. Thus, the null model classifies correctly 49.1% of the time.

Table 7 summarizes the effect of each predictor. The ratio of the coefficient to its standard error, squared, equals the Wald statistic. If the significance level of the Wald statistic is small (less than 0.05) then the parameter is different from 0. Parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category, while parameters with positive coefficients increase the likelihood of that response category. The parameters associated with the last category of each factor is redundant given the intercept term ($B=0^b$). If the intercept were not included in the model, parameters associated with the last category of each factor would become non-redundant. In our study, parameters for Q_{15} and $Q_{23ii}=1$ are significant. The Exp(B) column reports the change in the odds of a fuelwood demand for a one-unit change in the predictor. The interpretation of these results is the following:

- Each "extra" m^2 of house decreases the odds of fuelwood demand been greater in the future by 0.977 times. In other words, respondents with big houses tend to consume less fuelwood, meaning that these consumers use other energy sources for heat.
- The belief that agricultural cultivations could be turned into forest plantations the odds of fuelwood demand been greater in the future by 171.755 times.

In the last few decades, especially because of the successive reforms of the CAP in 1992 and 1999, the afforestation of agricultural land has been financially supported, for both production of wood and protection of the environment.

A significant percentage of agricultural land, in both plain and mountainous area where one-year crops were cultivated, was replaced with forest plantations [63]. In Northern Greece and Thessaly in particular, this percentage was higher than that of the rest of the country.

6. Conclusions

Biomass and especially fuelwood consists a major source of energy in developing countries, particularly in rural areas. In Greece, in recent years and because of the economic crisis, there is an increased consumption of fuelwood, especially in rural areas.

By using a questionnaire and taking a random sample of 440 individuals from households that consume fuelwood in rural areas of the prefecture of Kozani, we examined the factors affecting consumption. By using logistic regression, we found out that the size of one' house and any changes in the use of land from agricultural to forestry – i.e., by planting forest trees in farmlands – play a significant role in the consumption of fuelwood.

The increase in forest production, and especially in wood, is one of the main goals of forest policy. Expenditures and general efforts to restore the Greek degraded forests, to rationalize their management and exploitation, were increased during the postwar period. Consequently, the production of wood was increased. However, despite the increase of domestic wood production since 1950 from natural forests, Greece imports large amounts of wood. The use of farmland and forest bare land is necessary to increase the general wood production and especially the production of fuelwood.

Increasing production of fuelwood from both the agricultural and the forest land will create new jobs in rural areas and contribute to the development and the achievement of social and environmental sustainability at local, regional and national level. Based on the above mentioned, a broad land use planning, which takes into account both the biophysical characteristics of the land and the social, economic, cultural and political status of the region is required. The study of existing land use is essential before planning an alternative use, because such studies handle time series data under well-known combinations of socio-economic and political status.

The supply of households with sufficient quantities of fuelwood in low prices could be achieved through wise management of forests, exploitation of residues from logging, increase of forests through reforestation and the establishment of forest plantations on agricultural land.

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